

**Science Instruments and Sensors *Capability* (Team
#12) Roadmap Activity**

Status Report to *Strategic* Team #4

NASA Chair: Rich Barney, GSFC

External Chair: Maria Zuber, MIT

Vis - IR - FIR subteam co-lead: Craig McCreight

February 15, 2005

Capability Description

- **The Science Instrument and Sensor Capability Roadmap Team will investigate current NASA exploration and science measurement strategies, mission formulation concepts, and science instrument/sensor technology roadmaps to identify critical science measurement capability gaps and assess future technology development needs. Specific science instrument and sensor groups include the following:**
 - **Active / Passive Microwave Remote Sensing**
 - **Multi-Spectral Imaging / Spectroscopy**
 - **Laser / LIDAR Remote Sensing**
 - **Direct Sensing of Fields, Waves, and Particles**
 - **In Situ Measurements**
- **This information will be integrated with extensive science and engineering community input to develop capability roadmaps that will identify driving science missions and their capability needs along with a technology demonstration process that leads to spaceflight. Priority consideration will be given to instrument and sensor technologies that (1) achieve goals closely aligned with the Exploration Vision and (2) constitute a major capability advancement required to achieve high-priority science measurement goals.**

Team Membership

Co-Chairs

- **NASA: Richard Barney, NASA/Goddard Space Flight Center**
- **NASA Deputy: Juan Rivera , NASA/GSFC**
- **External: Maria Zuber , MIT**

Team Members

Government

Brian Ramsey, MSFC
Bruce Spiering, Stennis
Tim Krabach, JPL
Soren Madsen, JPL
Paul Mahaffy, GSFC
Azita Valinia, GSFC
Craig McCreight, ARC

Industry

David Chenette, LM
Ron Polidan, NGST
Rich Dissly, BATC

University

Chris Ruf, UMichigan
Steve Ackerman, UWisconsin
Suzanne Staggs, Princeton

Other/Independent

Richard McEntire, APL
David Glackin, Aerospace

Coordinators

Directorate: Harley Thronson, SMD
APIO: Perry Bankston, JPL

Ex-officio

Carl Stahle (GSFC-Nano CRM)
Louis Barbier (NASA-SEU Technologist)
Amy Walton (ESTO)
Thomas Black (NRO)

1.0 Active & Passive Microwave Remote Sensing:

- **Soren Madsen– NASA lead**
- **Chris Ruf- Non-NASA lead**
- **Dave Glackin**
- **Azita Valinia**
- **Juan Rivera**
- **Suzanne Staggs**

2.0 Multi-Spectral Imaging/Spectroscopy (vis-IR-FIR)

- **Craig McCreight-NASA lead**
- **Ron Polidan- Non NASA lead**
- **Bruce Spiering**
- **Rich Dissly**
- **Tim Krabach**
- **Steve Ackerman**

3.0 Multi-Spectral Sensing (UV-Gamma)

- **Brian Ramsey- NASA lead**
- **Dave Chenette- Non-NASA lead**
- **Ron Polidan**
- **Azita Valinia**
- **Juan Rivera**

4.0 Laser/Lidar Remote Sensing

- **Richard Barney- NASA lead**
- **Maria Zuber-Non NASA lead**
- **Rich Dissly**

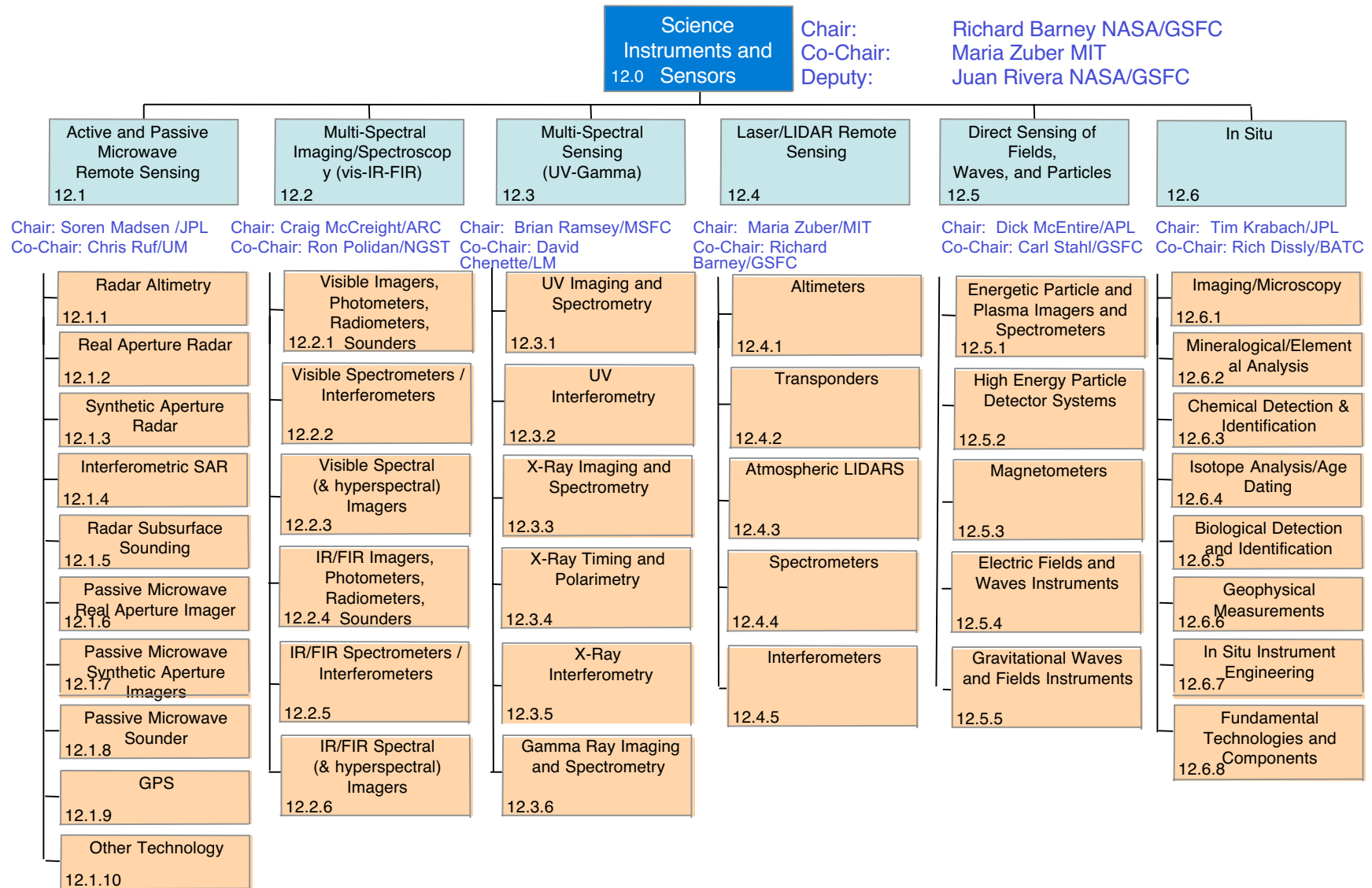
5.0 Direct Sensing of Fields, Waves & Particles

- **Carl Stahle- NASA lead**
- **Dick McIntire-Non NASA lead**
- **Tim Krabach**
- **Paul Mahaffy**
- **Dave Chenette**

6.0 InSitu

- **Tim Krabach- NASA lead**
- **Rich Dissly-Non NASA lead**
- **Dave Chenette**
- **Paul Mahaffy**
- **Dick McEntire**
- **Brian Ramsey**

Capability Breakdown Structure



Meetings & Inputs

Have held 3 team meetings (Dec, Jan, Feb)

Combination of talks by local (JPL, GSFC) scientists & technologists, plus committee work

February meeting included talk by K. Flanagan + S. Murray on Universe strategic roadmapping team status. Cited:

Con-X, LISA, Black Hole Finder, Black Hole Imager, CMBPol =
Einstein Inflation Probe, Big Bang Observer, JDEM, SAFIR,
LUVO, SPIRIT, SPECS, TPF-C, TPF-I, Life Finder

Documentation Hierarchy (per HQ)

- 1) Documents or reports directly related to the Exploration Vision
- 2) Other presidential or OSTP directives [e.g., 2001 Climate Change Research Initiative (CCRI)]
- 3) National Academy reviews, reports, recommendations
- 4) Pre-existing Enterprise plans and Reference Missions

Reference Documentation

(Docushare Library)

- Design Reference Missions (DRMs)
 - APIO DRMs
 - Solar System Exploration - 2000 to 2035 (Draft 3): DRM_SSE
 - Earth-Sun System: Potential Roadmap and Mission Development Activities (12/23/04)
 - Universe Design Reference Missions (12/13/04)
 - Architecture Study #2, Human Exploration of Mars, Artificial-Gravity Nuclear Electric Propulsion Option (7/15/03)
 - Reference Mission Version 3.0 Addendum to the Human Exploration of Mars (6/01/98)
 - Mars 98 Reference Mission: Reference Mission of the NASA Mars Exploration Study Team (7/7/97)
 - Lunar Surface Reference Missions: A Description of Human and Robotic Surface Activities (07/01/03)
 - The Mars Surface Reference Mission: A Description of Human and Robotic Surface Activities (12/01/01)
 - Other DRMs
 - Advanced Mission Studies: Mars Exploration Program Analysis Group
- Enterprise Strategies
 - Earth Science Application Plan
 - Earth Science Research Plan (Draft)
 - Sun-Earth Connection Roadmap (2003-2028)
 - Physics of the Universe: A Strategic Plan for Federal Research
 - Solar System Exploration Roadmap
 - Origins Roadmap (2003)
 - Structure and Evolution of the Universe Roadmap

Reference Documentation

(Docushare Library) (cont'd)

- National Research Council Reports
 - Astronomy and Astrophysics in the New Millennium Astronomy and Astrophysics Survey Committee, Board on Physics and Astronomy, Space Studies Board
 - Implementing Climate and Global Change Research: A Review of the Final U.S. Climate Change Science Program Strategic Plan Committee to Review the U.S. Climate Change Science Program Strategic Plan
 - New Frontiers in the Solar System: An Integrated Exploration Strategy Solar System Exploration Strategy, NRC
 - Solar and Space Physics and Its Role in Space Exploration Committee on Assessment of the Role of Solar and Space Physics in NASA's Space Exploration Initiative, NRC
 - The Sun to the Earth -- and Beyond: A Decadal Research Strategy in Solar and Space Physics Solar and Space Physics Survey Committee
 - The Sun to the Earth -- and Beyond: Panel Reports Solar and Space Physics Survey Committee, Committee on Solar and Space Physics
 - Connecting Quarks with the Cosmos: Eleven Science Questions for the New Century, Committee on the Physics of the Universe, NRC
- A Journey to Inspire, Innovate, and Discover: President's ('Aldridge') Commission Report
- Our Changing Planet: The US Climate Change Science Program for Fiscal Years 2004 and 2005
- The Vision for Space Exploration
- Detector Working Group Reports: Blades' for visible; Young's for IR-FIR-Submm-MM

Science Traceability Spreadsheet (sample)

Strategic Roadmap Reference	Science Question	Relevant Missions (Design Reference Mission; exceptions noted in red)	Launch Date	Measurement Parameter	Measurement Scenario	Target Body	Major Technology Gap Exists?	Document Reference	CBS Reference (Level 1)	Technology Component Development
8	Is there observational evidence supporting the hypothesis that the early universe underwent a period of rapid inflation?	Einstein Inflation Probe	2012-2020	Polarization structure of the cosmic microwave background	Map the polarization structure of the cosmic microwave background to detect the signature of gravity waves produced by an inflationary expansion.	Cosmic Microwave Background	Yes	2,3		Very large microwave /FIR arrays, 100 mK cryo-cooler, wide-band receiver
		Big Bang Observer	2025+	Gravitational waves	Directly observe gravitational waves with sufficient sensitivity to observe the background due to quantum fluctuations during inflation.	Gravitational Wave Background	Yes	2,3		Disturbance isolators, high-power lasers, precision mirrors
8	What was the structure of the early Universe?	Constellation-X	2014	X-ray spectra	Measure the X-ray spectra of quasars at high redshift and of the earliest galactic clusters	High-Z quasars, active galactic nuclei, and galactic clusters		1,3		
		Generation X	2025+ (?)	X-ray spectra	Measure the X-ray spectra of quasars at high redshift and of the earliest galactic clusters, down to sources 100-1000 times fainter than can be detected by Constellation-X	High-Z quasars, active galactic nuclei, and galactic clusters	Yes	1,3		Very large light-weight X-ray optics
8	What is the geometry of the Universe and the nature of dark energy?	Laser Interferometer Space Antenna (LISA)	2010	Gravitational waves	Measure gravitational waves from distant, merging black holes. These will be self-calibrated "standard candles" by which to gauge the geometry of the Universe and to constrain the nature of dark energy	Merging massive black holes		2,3		

1. Astronomy and Astrophysics in the New Millennium, 2004, NRC Astronomy and Astrophysics Survey Committee (Note that this is a National Academy study rather than a specific NASA roadmap)
2. Design Reference Missions -- Universe, NASA Document
3. Beyond Einstein: From the Big Bang to Black Holes, 2003, Structure and Evolution of the Universe Roadmap Team

Present Activities, Concerns

- Preparing for March 17 all-day presentation to Nat'l Research Council panel
- Do we have the right mission set(s) -- & what are the priority missions?
- Roadmapping approach: identify technologies with broad applicability, but also list other key, but more specific, technologies.
- Identifying linkages to other technologies & panels: e.g., large telescopes, nanotechnology, *in situ*, cryogenics. Identifying infrastructure items: device fabrication, detector testing, packaging.

Appendix

Capability Crosswalk

	1. High-energy power and propulsion	2. In-space transportation	3. Advanced telescopes and observatories	4. Communication & Navigation	5. Robotic access to planetary surfaces	6. Human planetary landing systems	7. Human health and support systems	8. Human exploration systems and mobility	9. Autonomous systems and robotics	10. Transformational spaceport/range technologies	11. Scientific instruments and sensors	12. <i>In situ</i> resource utilization	13. Advanced modeling, simulation, analysis	14. Systems engineering cost/risk analysis	15. Nanotechnology
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Same element	
Critical Relationship (dependent (D), synergistic (S), enabling (EN))	
Moderate Relationship (enhancing (EH), limited impact (LI), Limited Synergy (LS))	
No Relationship	

Strategic Roadmap Traceability

Strategic Roadmap #		1	2	3	4	8	9	10
<u>12.0 Science Instruments and Sensors</u>		Moon	Mars	Solar System	Earth-like Planets	Universe	Earth	Sun-Solar System
		Robotic and Human Lunar Exploration	Robotic and Human Exploration of Mars	Solar System Exploration	Search for Earth-Like Planets	Universe Exploration	Earth Science and Applications from Space	Sun-Solar System Connection
12.1	Active & Passive Microwave Remote Sensing							
12.2	Multi-Spectral Imaging/Spectroscopy (IR-Vis)							
12.3	Multi-Spectral Imaging/Spectroscopy (UV-Gamma)							
12.4	Laser/LIDAR Remote Sensing							
12.5	Direct Sensing of Fields, Waves & Particles							
12.6	InSitu							

Legend: Driven by Design Reference Missions or Strategic Roadmap Guidance

No Science Drivers